Global Journal of Research in
Science and Technology
Journal homepage: https://gsjournals.com/gjrst/
ISSN: 2980-4167 (Online)

(RESEARCH ARTICLE)

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Evaluation of micronutrient status of unburnt and burnt coffee plantation in Ibadan

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Global Journal of Research in Science and Technology, 2022, 01(01), 022–025

Publication history: Received on 14 August 2022; revised on 17 September 2022; accepted on 20 September 2022

Article DOI: https://doi.org/10.58175/gjrst.2022.1.1.0015

Abstract

The micronutrient status of the soils and leaf of unburnt and burnt plots of coffee plantation to study the soil-plant micronutrient content relationship in the coffee plantation soil for proper management towards optimum production of the crop was investigated at Ibadan, Oyo State, Nigeria. Soil samples were collected from the burnt and unburnt plots in the coffee plantation at 3 depth of 0-20 cm, 20-40 cm and 40-60 cm were bulked into composite samples. Leaf samples of burnt and unburnt plots were collected at the same plantation soil pit for both locations.The soil samples were analyzed for the micronutrients manganese(Mn), iron (Fe), copper (Cu) and zinc (Zn) and in addition pH and organic carbon, while the leaves were analyzed for only the micronutrient contents. Results obtained from the unburnt and burnt plots indicated that the organic carbon content of the soil was low and the soil is deficient in Cu and Zn but very in Mn and Fe content. The micronutrient content of the leaves was deficient in Mn, Cu, and Zn but high in Fe. This probably resulted in nutrient imbalance in the soils and the deficiency of the nutrients in the crops. Soil and leaf micronutrient concentration were found insufficient for coffee plantation in the study area. The plantations therefore require application of organic manures and micronutrient fertilizers to rectify the inadequate soil organic matter and to supply sufficient amount of Cu and Zn in the soils, to obtain quality berry yield at optimum level from the plantation.

Keywords: Micronutrient; Soil; Leaf; Coffee plot

1 Introduction

Coffee is one of the most important export crops in Africa and Latin America Countries[1]. Coffee is a major commodity crop of economic importance in the international market. It is cultivated for the berries which are of value for good health of main Nigeria has fared prominently in the cultivation of coffee in the past but Nigeria contribution to the World market presently have been declining over the past few decades due to oil boom that lead to farms to be abandoned by the poor resources farmers [2]. The old age of the farms, soil fertility problems and detrimental climate change and detrimental increase in soil pH results in increase metal concentration in the soil. The result obtain is in agreement with the earlier findings of Nath, [3]. Most of the plantations are over 50 years old and have become wasteful assets owing to old age, poor maintenance and lack of fertilizer application, severe pests and diseases attack as well as a combination of these factors [4]. Attempt to replant the plantations with improved seedlings have not been successful due to high soil Cu residue on coffee plantations [5], deficient and imbalanced soil nutrients [6]. It therefore shows that decline in soil fertility, imbalance use of fertilizer nutrients are subjects of concern towards solving low yield of the crops in most of the plantations in Nigeria. Nigerian soils lack of adequate plant nutrients and organic matter [7]. Hence, most of the tree crop plantations in Nigeria are established on medium to low fertility status soils with resultant low yield by farmers. Coffee plantation soils in Uhonmora,Edo State was very low in organic carbon, Cu and Mn contents but high in Zn and Fe contents, which must have lead to nutrient imbalance and deficient supply of the nutrients to the crops. To correct the micronutrient imbalance on the plantations, suggestion therefore is that adequate auditing of the soil nutrients are needed to be carried out periodically [8].

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Improper fertilizer recommendation because of lack of adequate soil testing has resulted to imbalance supply of nutrients to crops [9]. This study was therefore carried out to assess the micronutrient status of unburnt and burnt areas of coffee plantation in Ibadan area of Oyo State, Nigeria.

2 Material and methods

Soil and leaf samples were collected from coffee plantation in Ibadan, located on longitude 3^0 54^1 E and latitude 7^0 30^1 N with sub humid climatic condition and bimodal rainfall of 1300mm per annum, which start from April-July, August-November. The maximum temperature ranges between 26^0C to 35^0C with an average of 30.5^0 C and the minimum ranges from 15^0C to 24^0C with an average of 19.5^0 C. The soil is classified as an alfisol [10]. Soil samples were burnt and unburnt areas within the coffee plantation at a depth of 0-20, 20-40 and 40-60 cm using soil auger, air-dried and crushed to pass through 2mm sieve and some of the physical and chemical properties of the soil determined. Soil samples were analyzed for its organic carbon, pH, Mn, Fe, Cu, and Zn. The soil pH was measured using sensitive electrode pH meter in water ratio of 2:1. Organic carbon was determined by wet dichromate oxidation method. The cations were extracted with ammonium acetate. The Mn, Fe, Cu and Zn were read with the atomic absorption spectrophotometer. The leaf samples were collected and kept inside envelope, oven-dried and milled using stainless still hammer mill and analyzed for their micronutrient content.

3 Results and discussion

The analytical results of soil samples (table) showed that the soil pH ranged from 6.34 to 6.62 with mean value of 6.53 for unburnt while burnt ranged from 6.94 to 7.26 with a mean value 7.14. Both soil pH value are found to be Alkaline. Soil pH for both unburnt and burnt were slightly above the soil pH range ideal for coffee plantation 5.6%-0.98%.

The soil organic carbon contents for the unburnt and burnt coffee plots were ranged from 0.29-0.98% with mean value of 0.90% and 0.44-1.09% with mean value of 0.67% respectively. Soil organic (levels are far below the critical level of 3.0% recommended for optional growth of coffee [11]. The low soil organic carbon of the studied area must have resulted to very high pH level of the soil. The soil micro nutrient contents for the unburnt and burnt coffee plot in (Table 1 and 2) showed that the soil Mn ranged from 9.35-10.45 mg|kg with average value of 8.70 mg|kg and 0.85-8.15 mg|kg with mean value 3.61 mg|kg while Fe contents was 4.95-10.70 mg|kg with mean value of 7.07 mg|kg unburnt and 4.05-12.10 mg|kg with average value of 7.20 mg|kg for burnt. It was 1.00-1.20 mg|kg with mean of 1.11 mg|kg soil for Cu of unburnt and 0.73-1.11 mg|kg with mean value 0.94 mg|kg soil of Cu for burnt. Zn contents for the unburnt and of Cu for burnt. Zn contents for the unburnt and burnt plot ranged from 0.87-1.63 mg|kg with mean burnt from value of 1.31 mg|kg for unburnt and 1.05-2.20 mg|kg with mean value of 1.31 mg|kg for unburnt and 1.05-2.20 mg|kg with mean value of 1.31 mg|kg for unburnt. Generally, the soil micronutrient levels evaluation were not sufficient for coffee plants production. The soil Mn contents in (Table 1) in unburnt plot were higher with 8.70 mg|kg compared to the burnt coffee plot with 3.62 mg|kg. However, the use of fertilizer material that could supply some quantity of various micronutrients in the soil will be an added advantage in helping to replenish the soils of nutrients removed by crops through harvest of the berries.

This result is in agreement with earlier finding of Nath [3], who observes that increase in soil pH resulted to increase micronutrient for Mn, Cu, Zn and Fe concentration in soil sampled.

The copper and zinc micronutrient of unburnt and burnt fall below the maximum allowance limit of micro nutrient in soil (2 to 250mg for Cu and 10 to 300 mg|kg for Zn) respectively [12; 13]. These trace elements play an essential biological sole in plant and human metabolism [14]. The copper and zinc are considered as good source of protein.

The average value micronutrient status of unburnt and burnt soils in order Mn>Fe>Zn>Cu and Fe>Mn>Zn>Cu, the result obtained disagreement with Tomori et al. [15]. (Take 3) showed that Mn content of 0.6 mg|kg of burnt leaf of 1.45 mg|kg. The Mn content was high. Fe contents of the burnt leaf samples were 2.71 mg|kg and 1.83 mg|kg Fe for unburnt. Cu content of burnt plot is 0.214 mg|kg, while unburnt leaf Cu content value is 0.23 mg|kg. Zn contents value was 0.34 mg|kg for burnt plots and 0.15 mg|kg for unburnt plot. The overall results showed that the burnt plot of micronutrient evaluated were higher than unburnt plot. The ranged value of micronutrient leaf of unburnt and burnt plot Fe>Mn>Cu>Zn and Fe>Mn>Zn>Cu. The result obtained in the study area showed that Iron here is highest unburnt plot value followed by Mn and Zn was the least while on the burnt plot, Fe had the highest value followed by Mn and Cu was the least value.

The leaf micronutrient of unburnt and burnt coffee plot was deficiency compared to the allowable limit values. In this study, it showed that the results of soil and leaf micronutrient of unburnt and burnt plot were found to be insufficient.

Table 1 Soil Micronutrient Content of unburnt coffee plot

Depth (cm)	PH	OC (%)	Mn	Fe Mg|kg	Cu	Zn
0-20	6.34	0.98	6.30	5.55	1.14	1.63
20-40	6.64	0.53	10.45	4.95	1.20	1.43
40-60	6.62	0.29	9.35	10.70	1.00	0.87
Minimum	6.34	0.29	9.35	4.95	1.00	0.87
Maximum	6.62	0.98	10.45	10.70	1.20	1.63
Mean	6.53	0.90	8.70	7.07	1.11	1.31

Table 2 Soil Micronutrient content of burnt coffee plot

Depth (cm)	PH	OC (%)	Mn	Fe Mg|kg	Cu	Zn
0-20	6.94	1.09	8.15	12.10	0.73	2,20
20-40	7.25	0.49	1.85	4.05	0.99	1.15
40-60	7.24	0.44	0.85	5.65	1.11	1.05
Minimum	6.94	0.44	0.85	4.05	0.73	1.05
Maximum	7.26	1.09	8.15	12.10	1.11	2.20
Mean	7.14	0.69	3.61	7.26	0.94	1.46

Table 3 Leaf Micronutrient content of the unburnt and burnt coffee plots

Unburnt plot Leaf Micronutrient content (Mg|kg)	Burnt plot Leaf Micronutrient content (Mg|kg)
Mn 0.69	1.45
Fe 1.83	2.71
Cu 0.23	0.21
Zn 0.15	0.34

4 Conclusion

The result revealed that micronutrient contents of the soil and leaf samples were found insufficient for sustainable coffee production. It was recorded that the soil in the coffee plantation was very low in organic carbon, Cu and Zn contents but high in Mn and Fe contents, which must have led to nutrient imbalance and deficient supply of the nutrients to the coffee crop. To correct the micronutrient imbalance on the plantation, suggestion therefore is that adequate auditing of the soil nutrients are needed to be carried out periodically. This can be at the end of every cropping season main harvest, in order to know the soil nutrient balance. Wherever insufficiency in these nutrients are observed, corrections should be made appropriately in the next growing season to guide against low crop yield and poor harvest. The use of organic and inorganic fertilizers that could supply some quantity of the various micro-nutrients in the soil will be an added advantage in helping the soil of nutrients removed by the crop through harvest of berries.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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